

Stretch - Parameterized Light Curves for High-Redshift SNIa Studies

Alex Kim

Alex Kim
Lawrence Berkeley National Laboratory
Aug 5 1997

This work was supported by the Director, Office of Science,
Office of High Energy Physics, of the U.S. Department of
Energy under Contract No. DE-AC02-05CH11231.

Objective

Create a SNIa lightcurve template optimized to fit hi- z SN magnitudes

- Continuous parametrization
- Simple model for lightcurves
- No biases
- B lightcurve a good magnitude indicator
- Measure host extinction (hmm....)
- Template uncertainties and covariance
- Confined to B & V lightcurves at early epochs
- Low dispersion on Hubble diagram

Plan

1. Motivate our template model

2. Describe the model

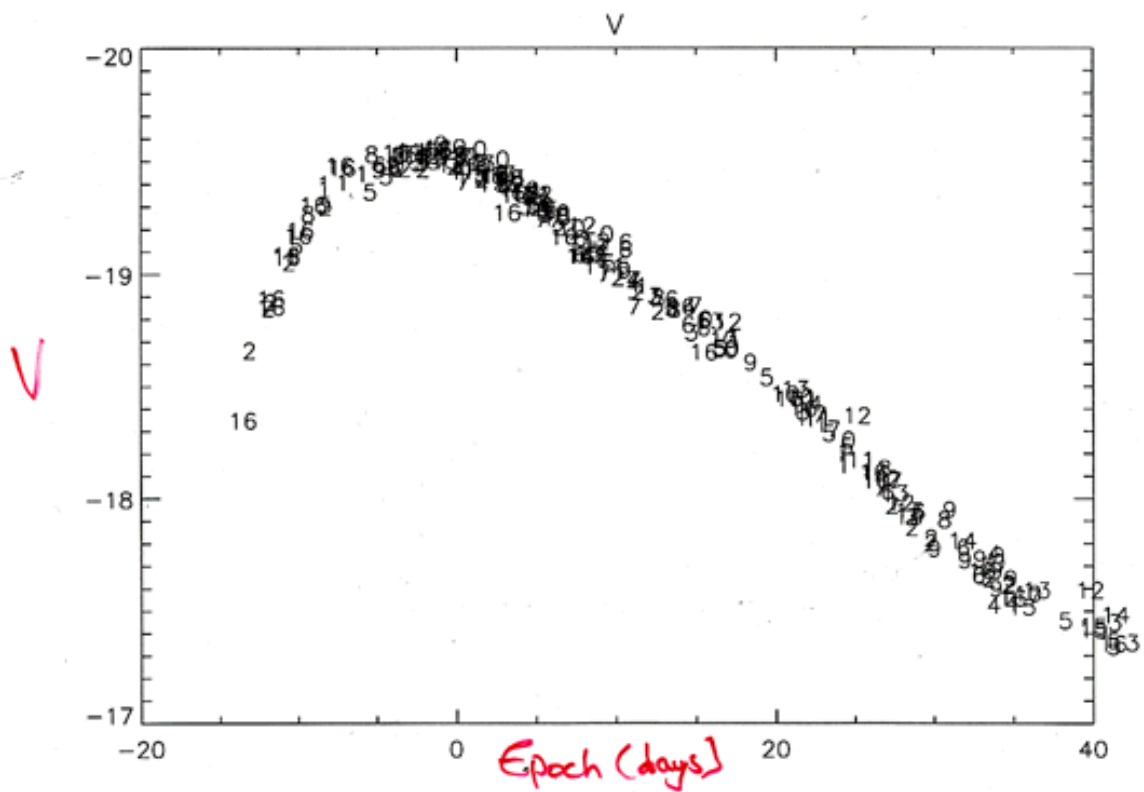
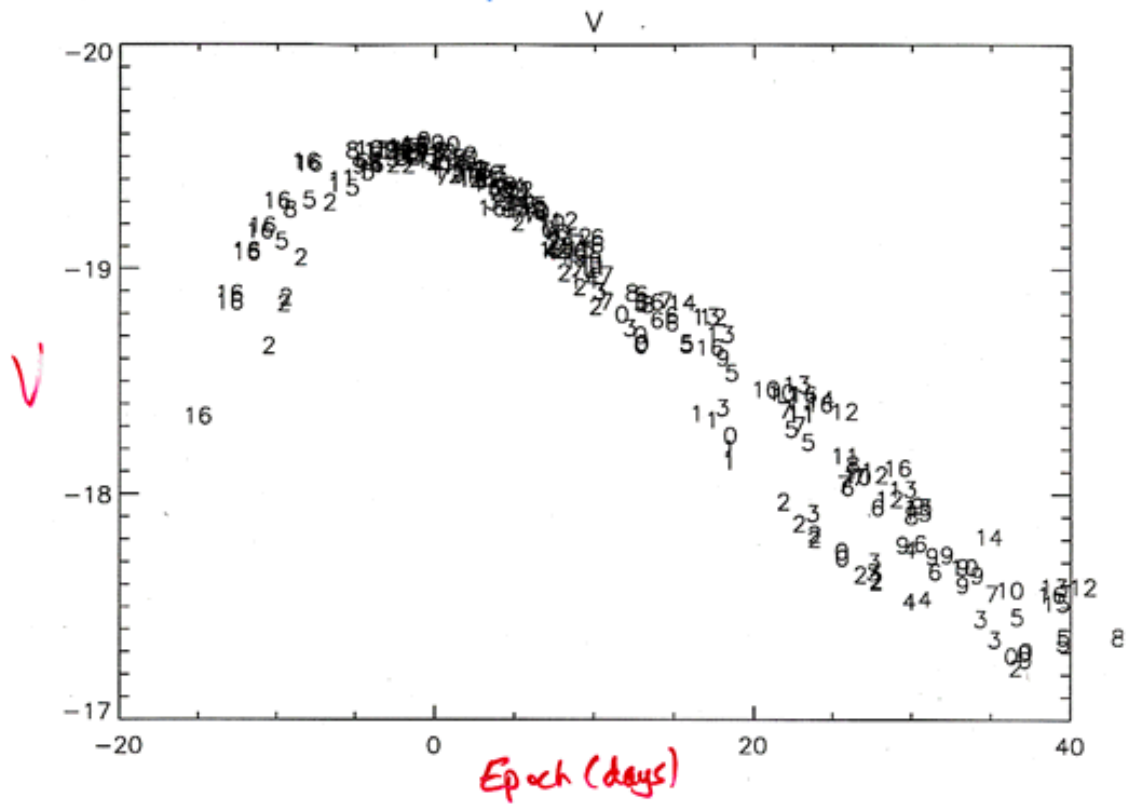
(Perlmutter et al. *ApJ* 483, 565 (1997))

3. The template!

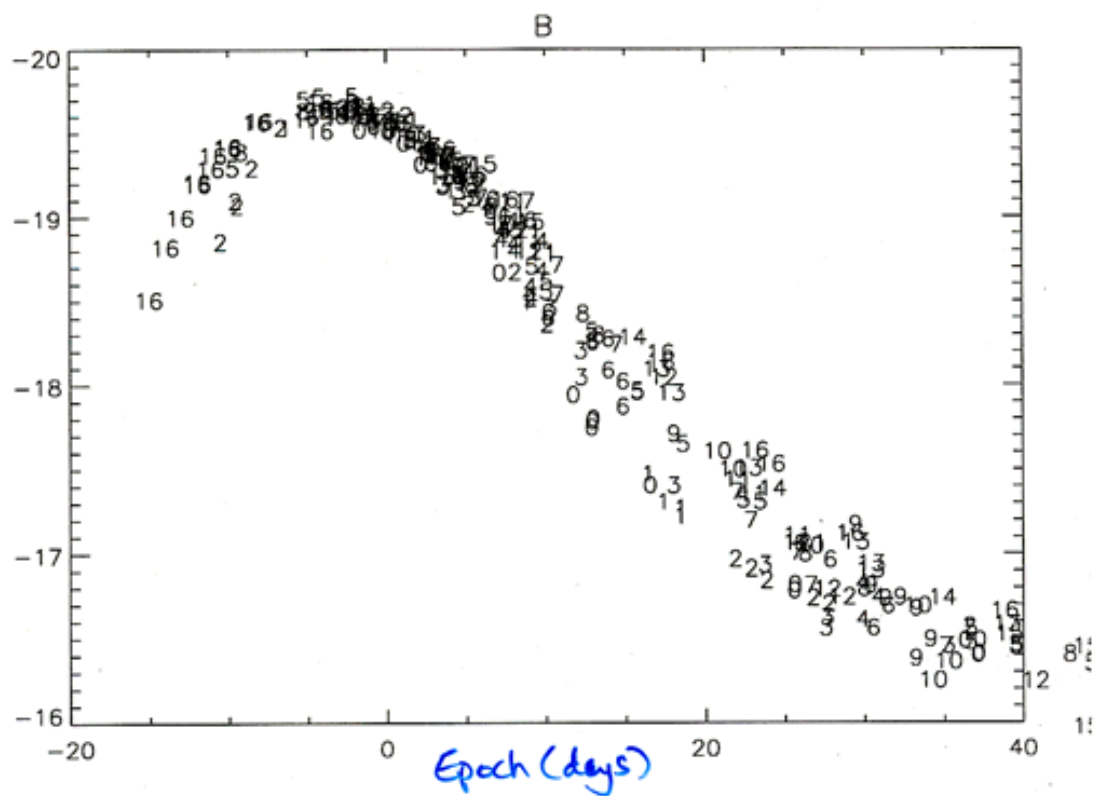
4. Testing the template.

5. Other interesting results

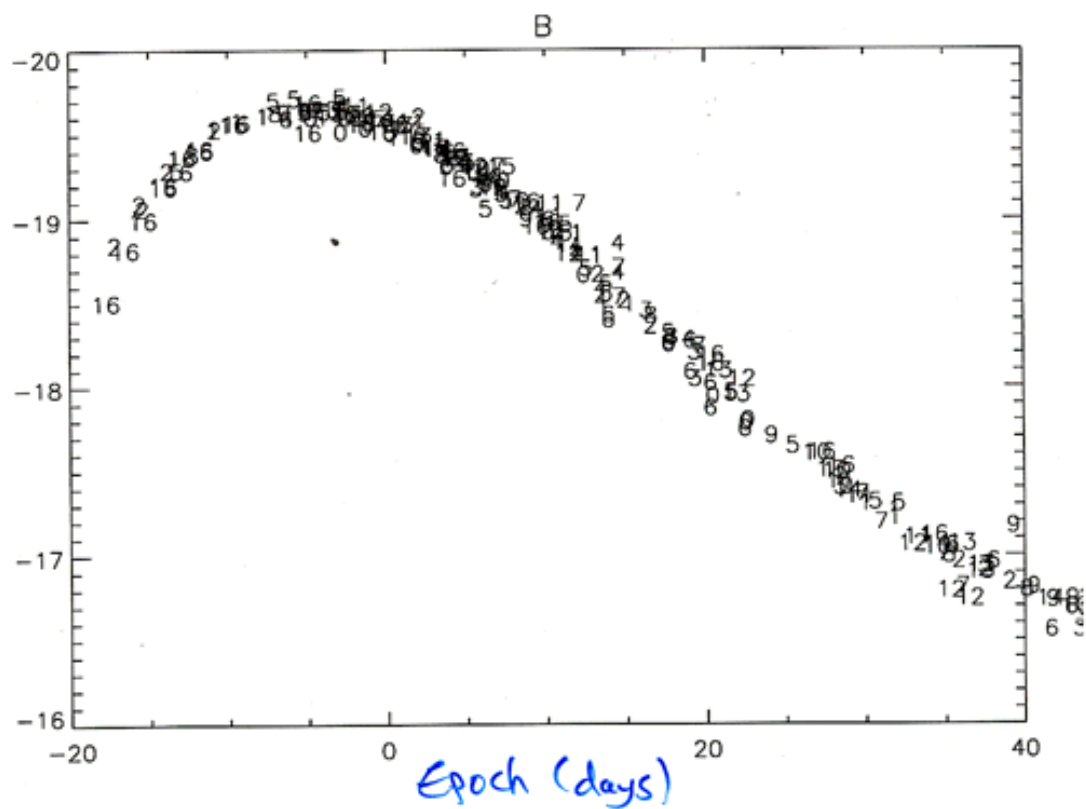
Hamuy et al. A.J. 112, 2408 1996

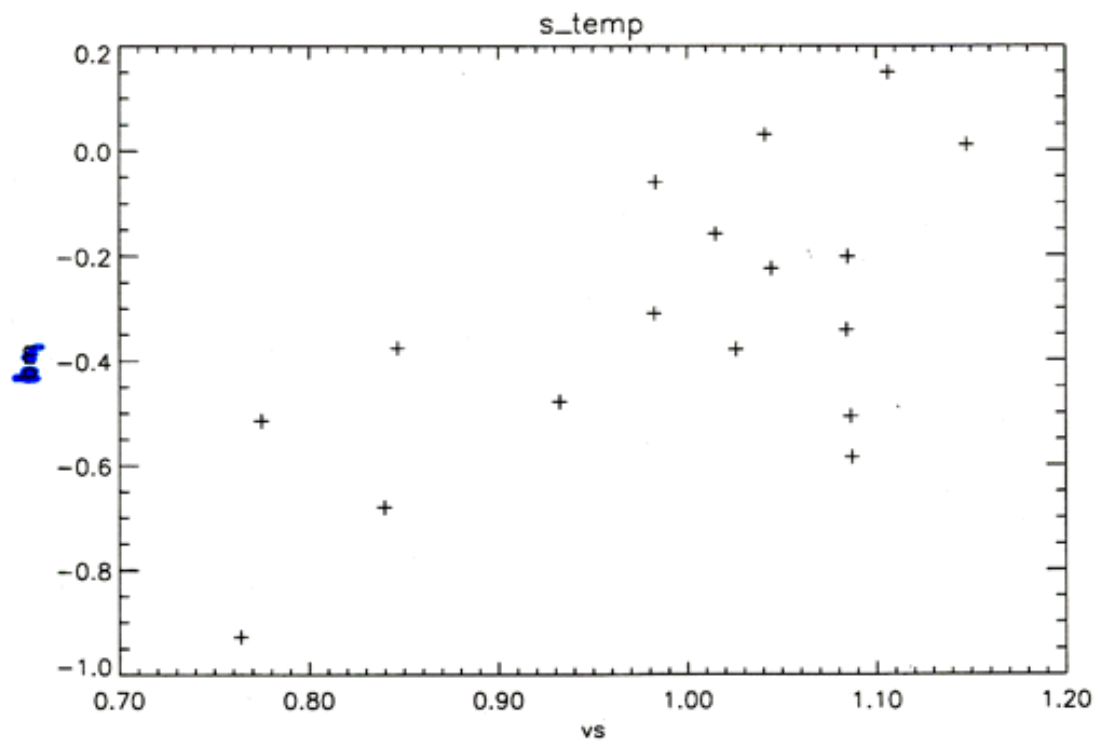
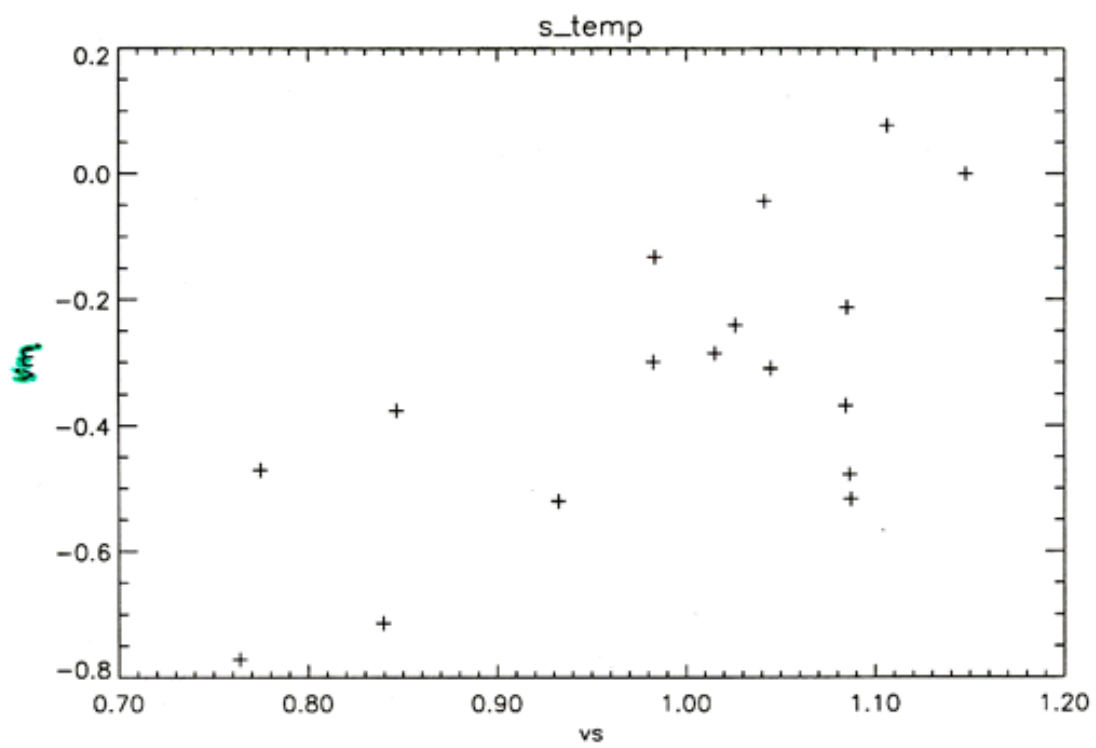


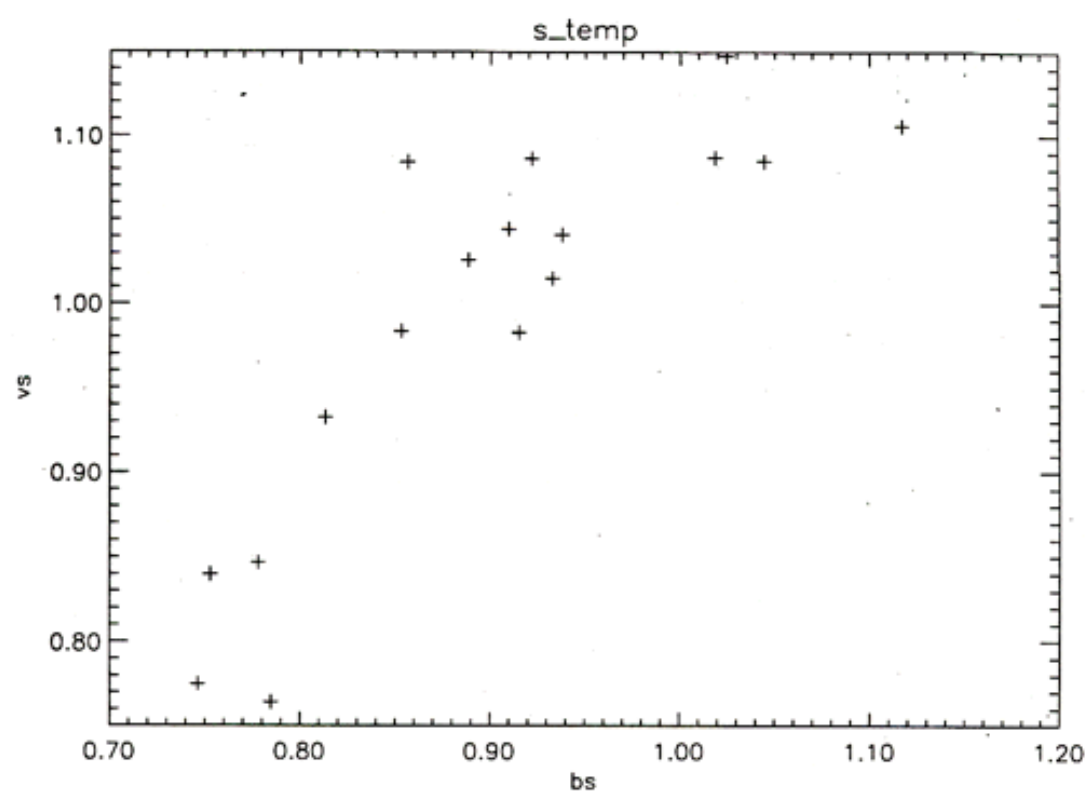
B



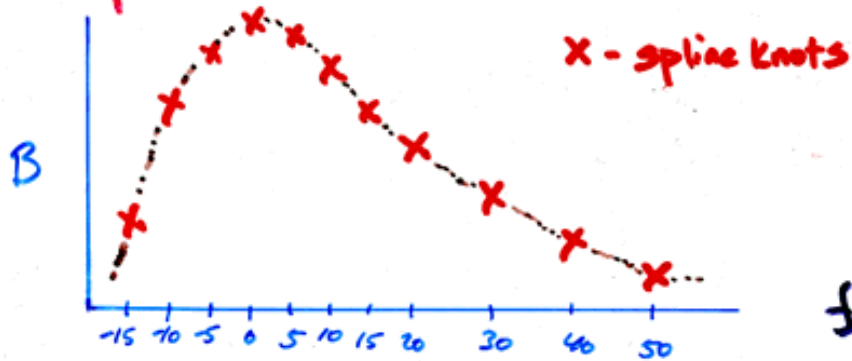
B







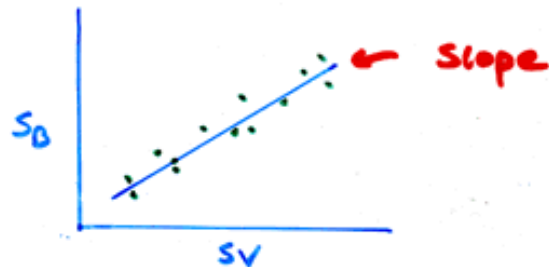
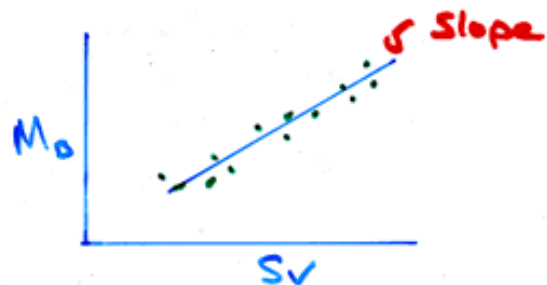
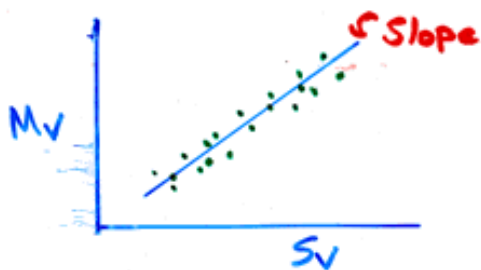
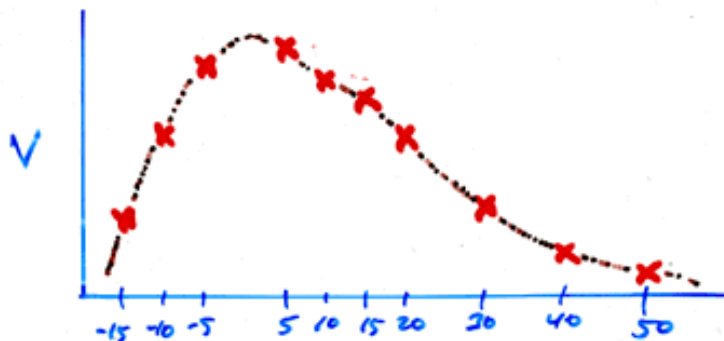
Template Model



for $S_V = 1$

$$M_V = -19.475$$

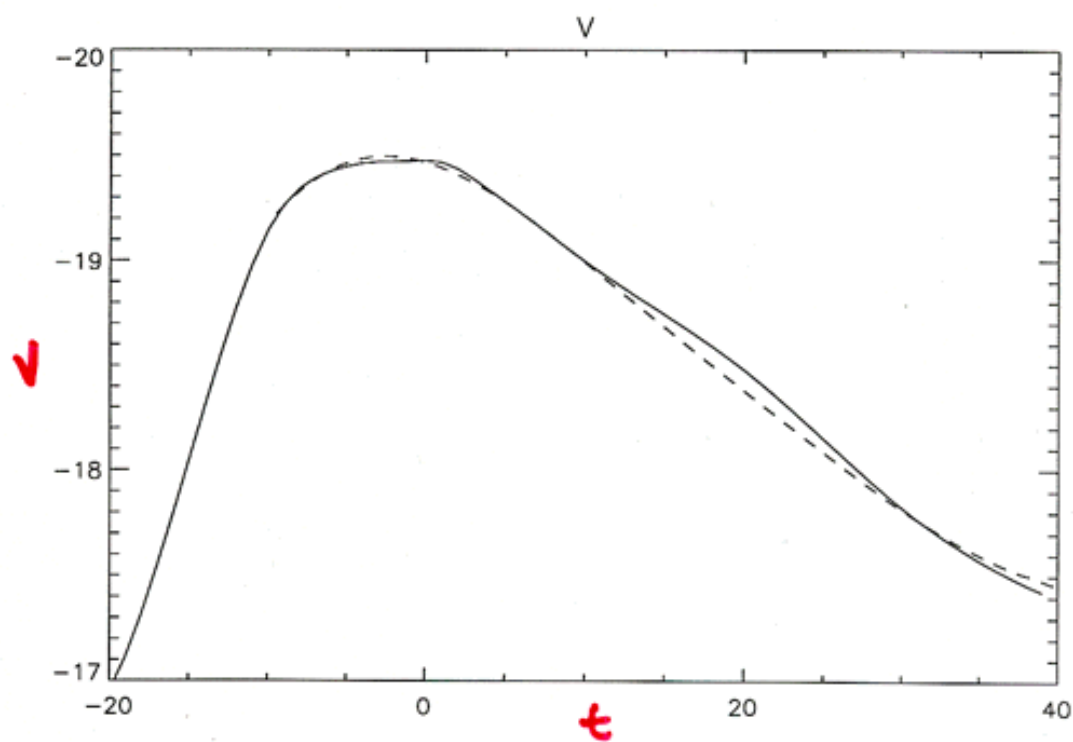
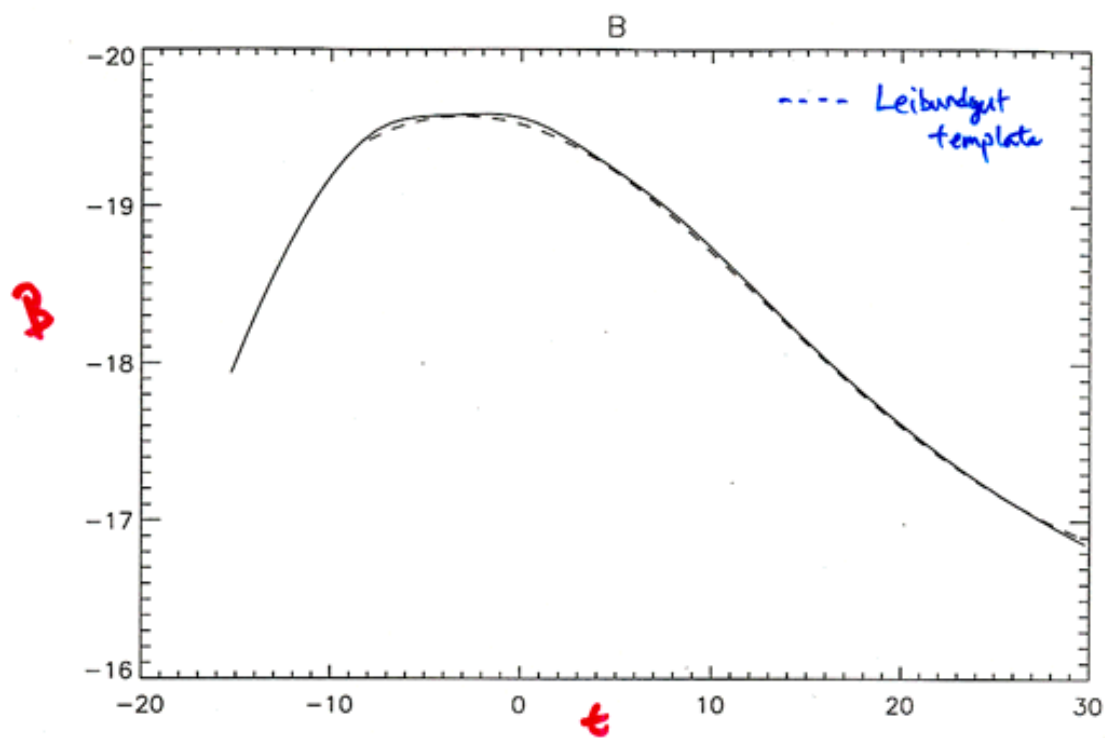
$$H_0 = 65 \text{ km/s/Mpc}$$



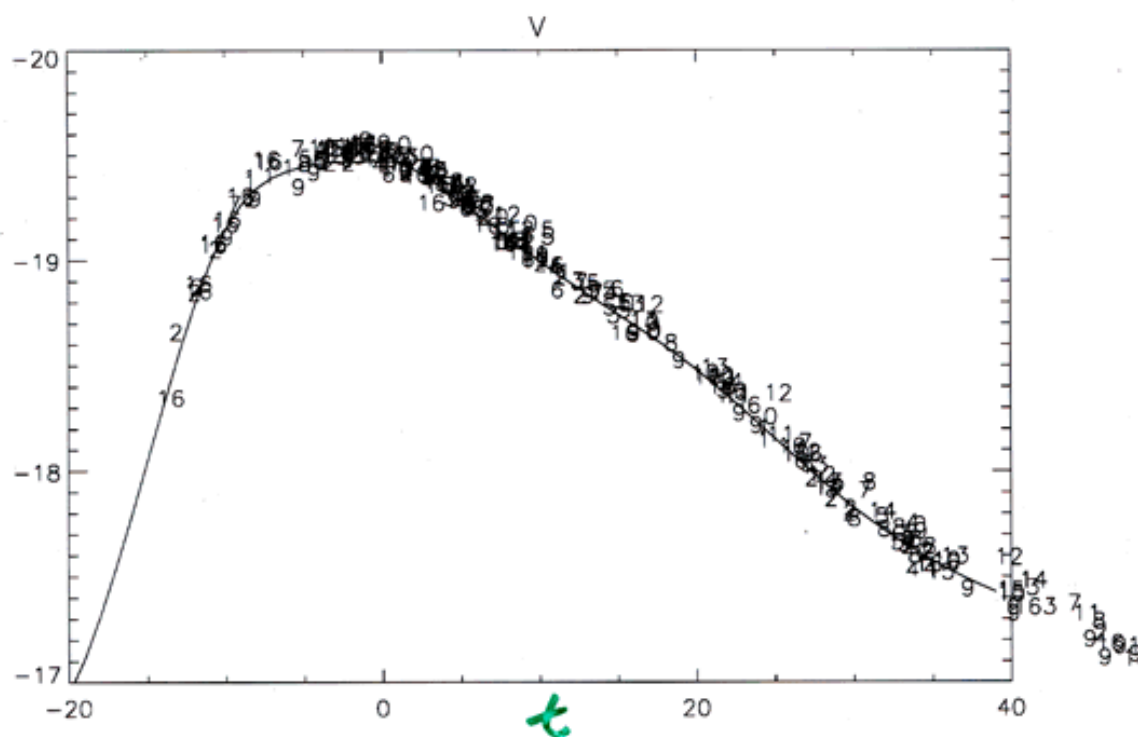
And for each supernova in the training set

$$S_V, t_{\text{max}}, E(B-V) \begin{cases} R_B = 4.1 \\ R_V = 3.1 \end{cases}$$

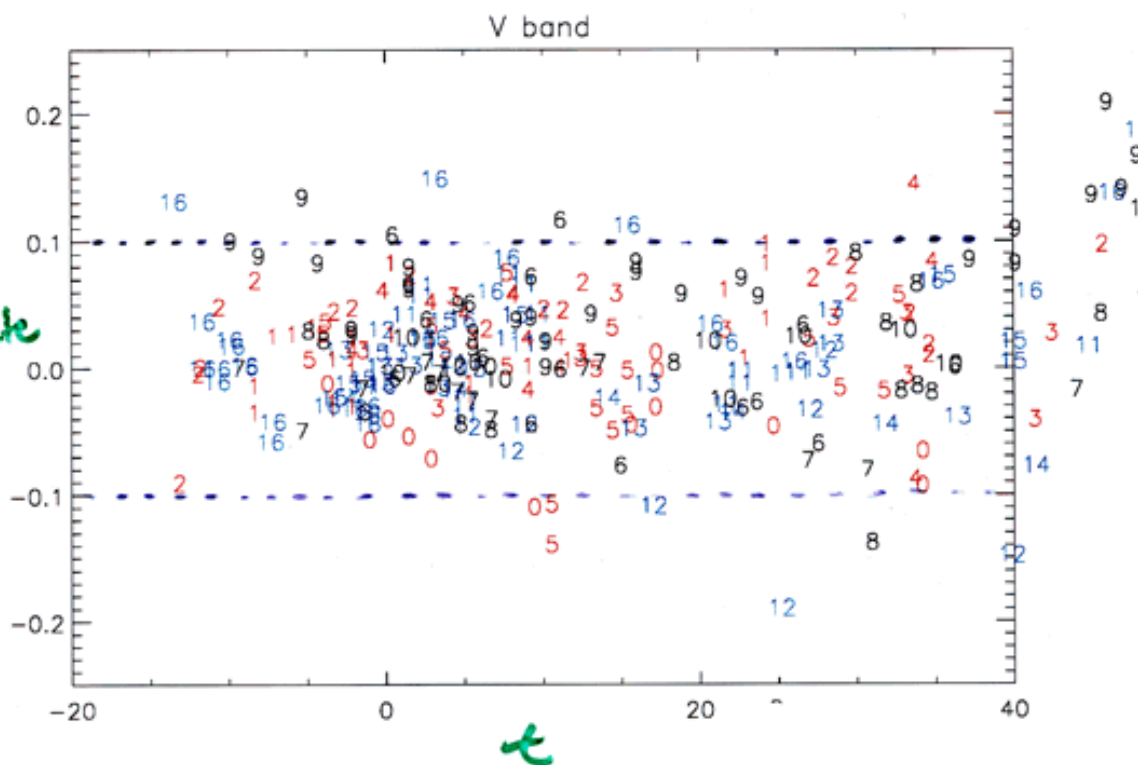
$$\Delta t_{\max} = 2.4 \text{ days}$$

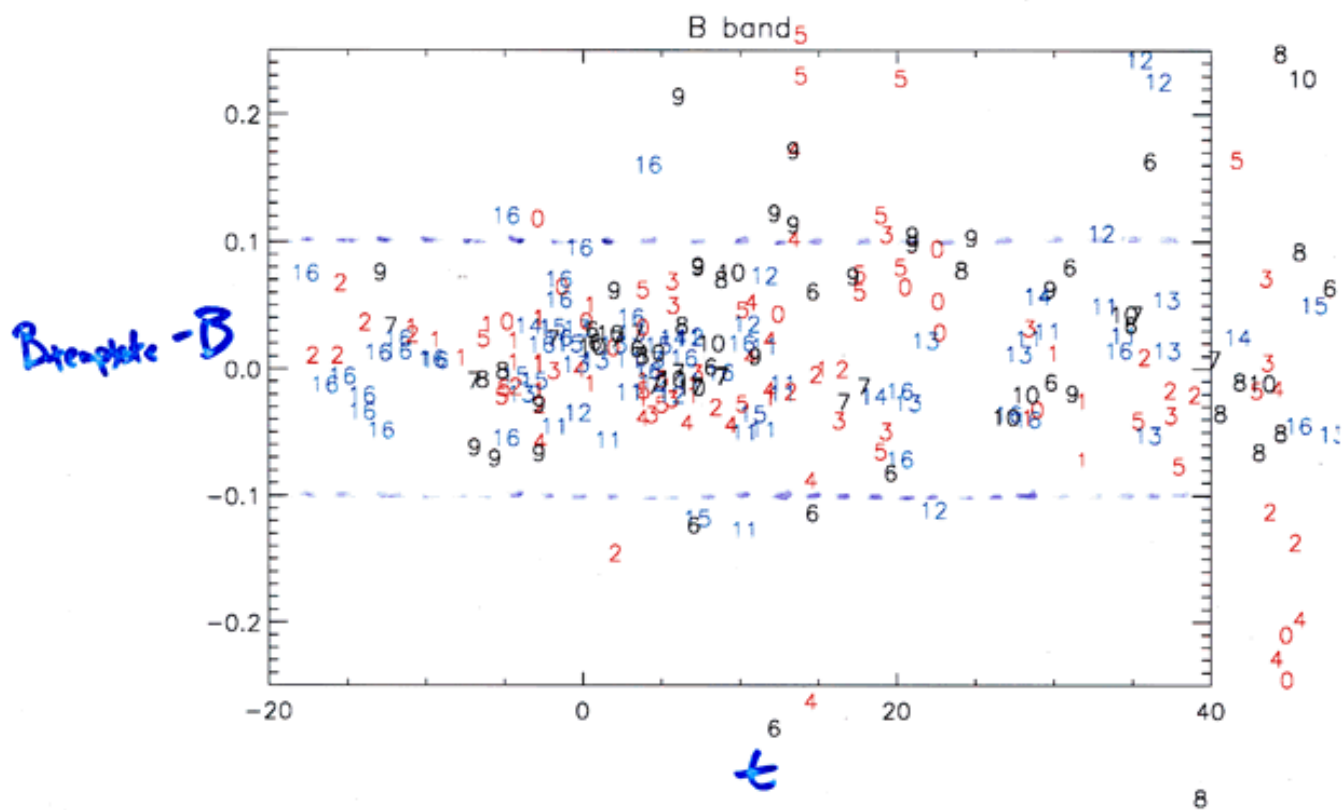
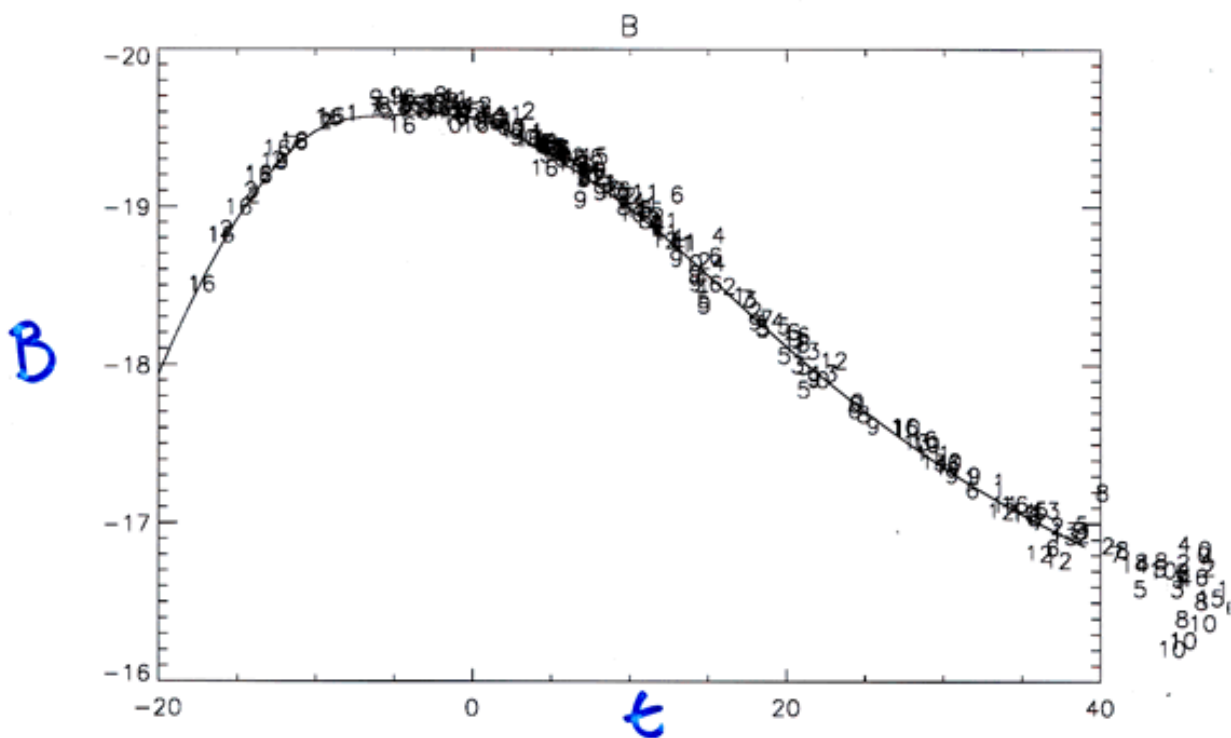


V

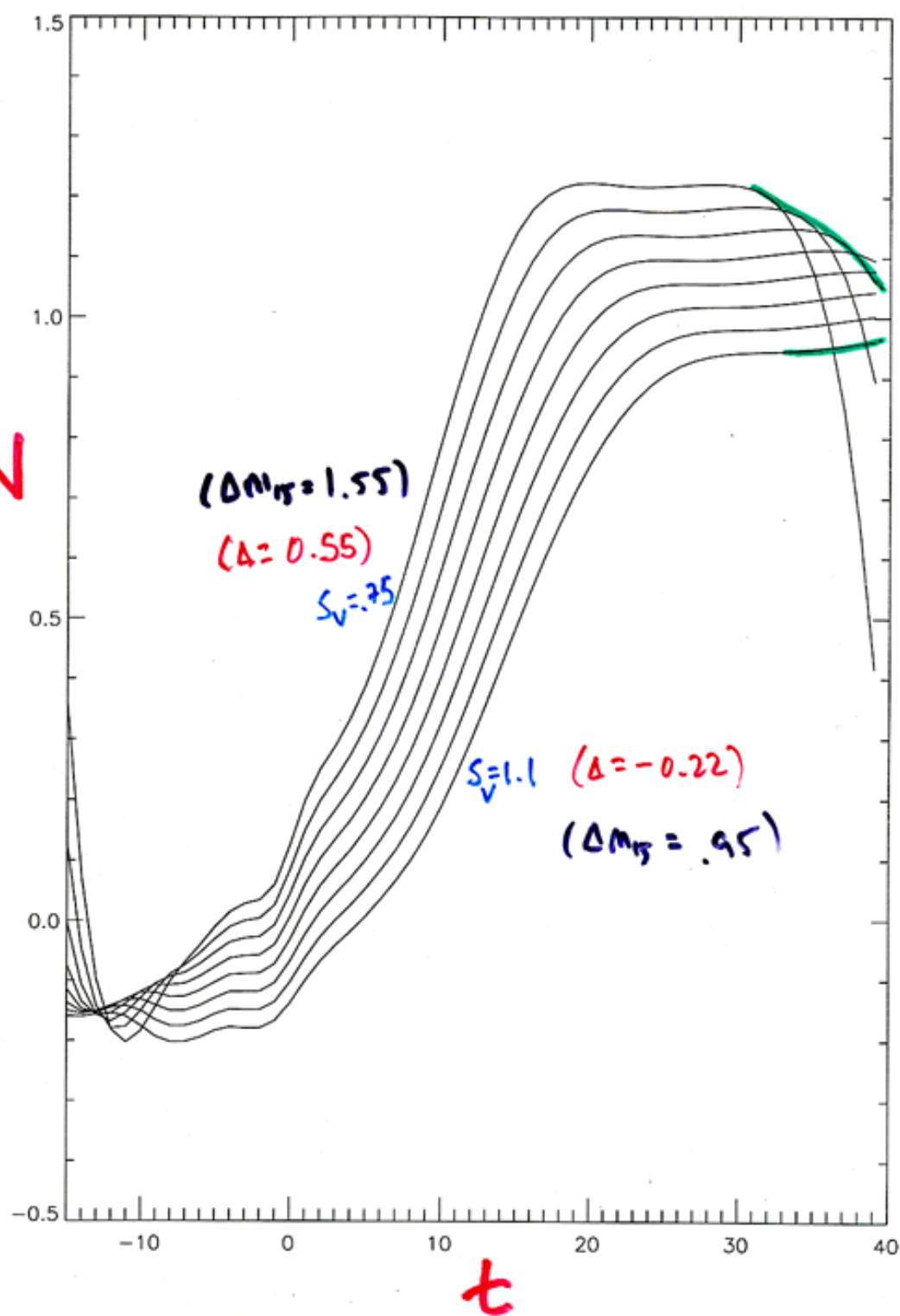


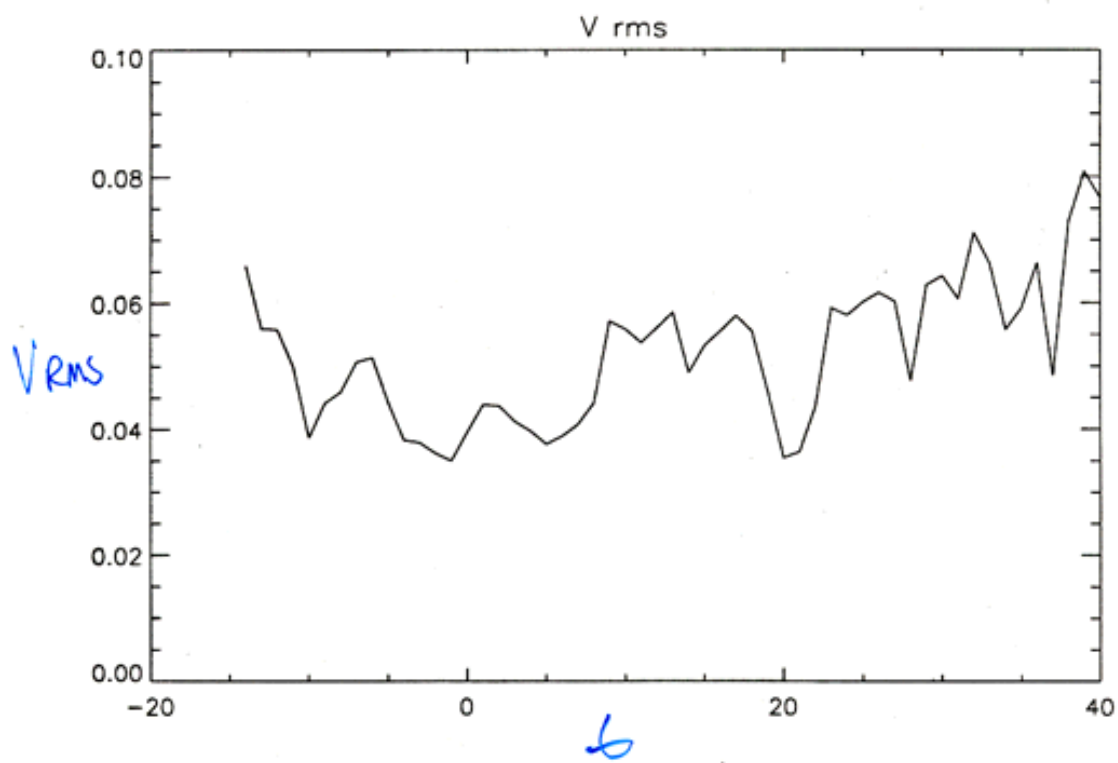
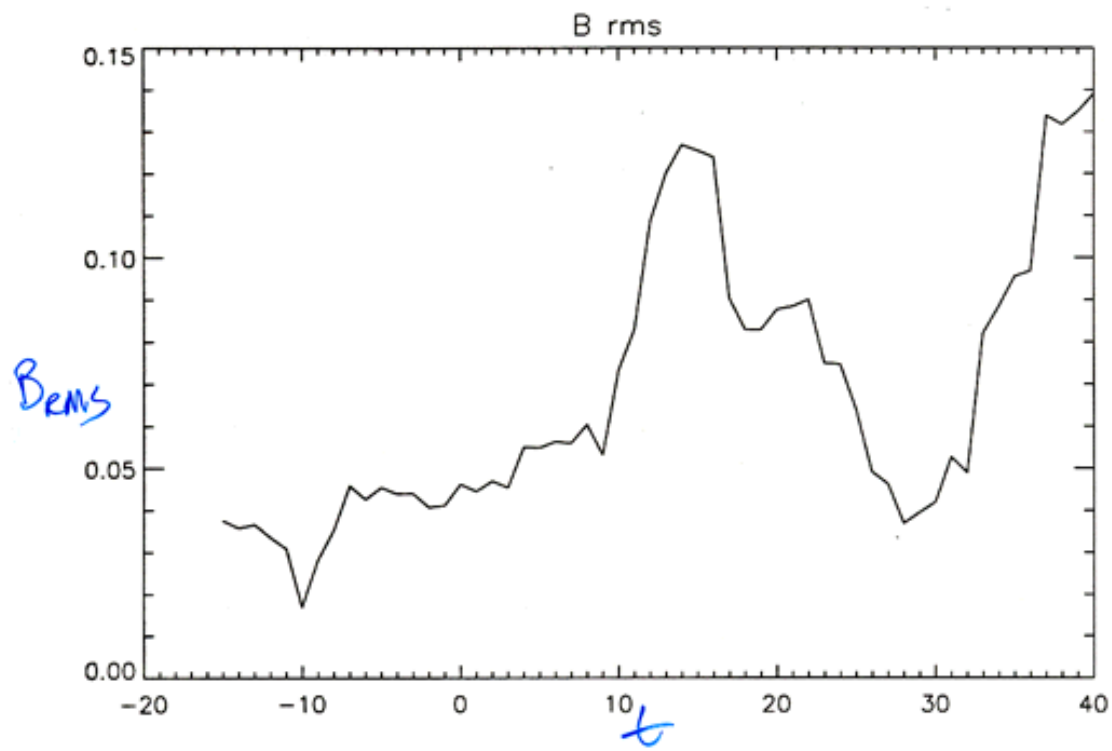
$-V + V_{\text{Template}}$

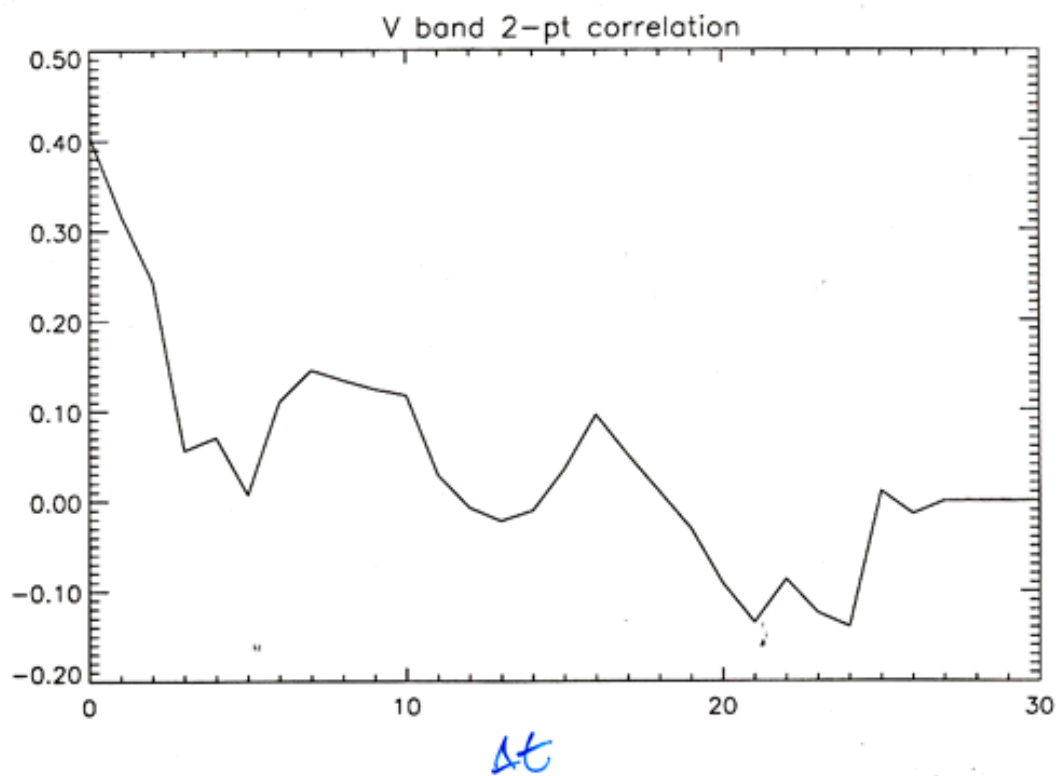
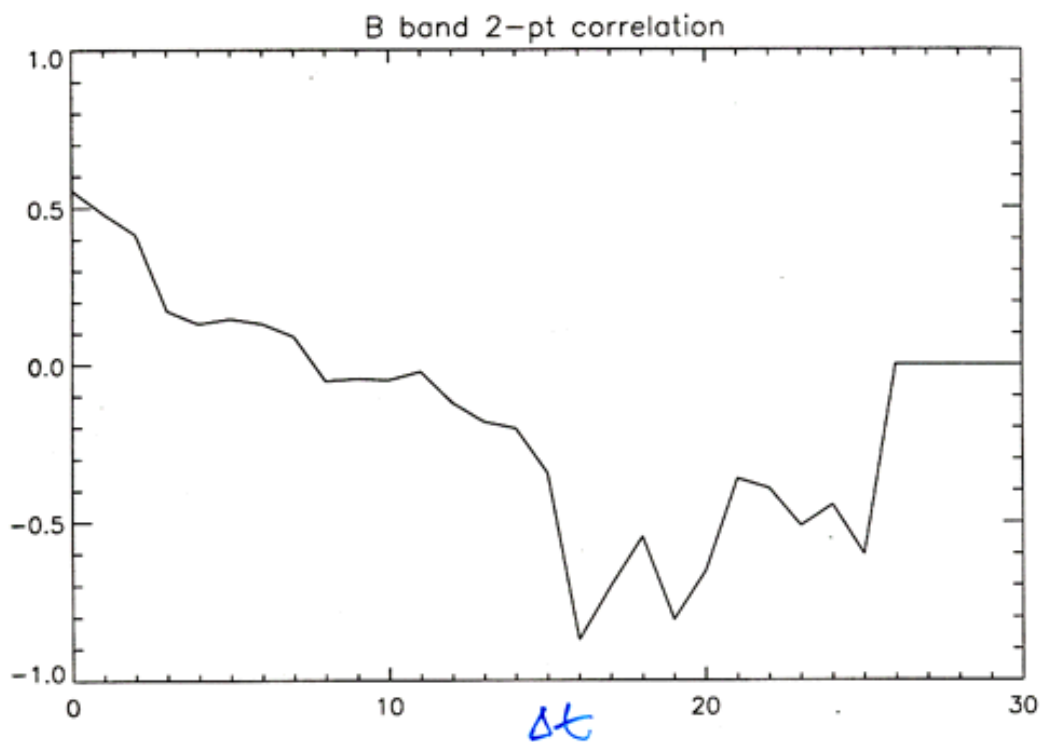




B-V



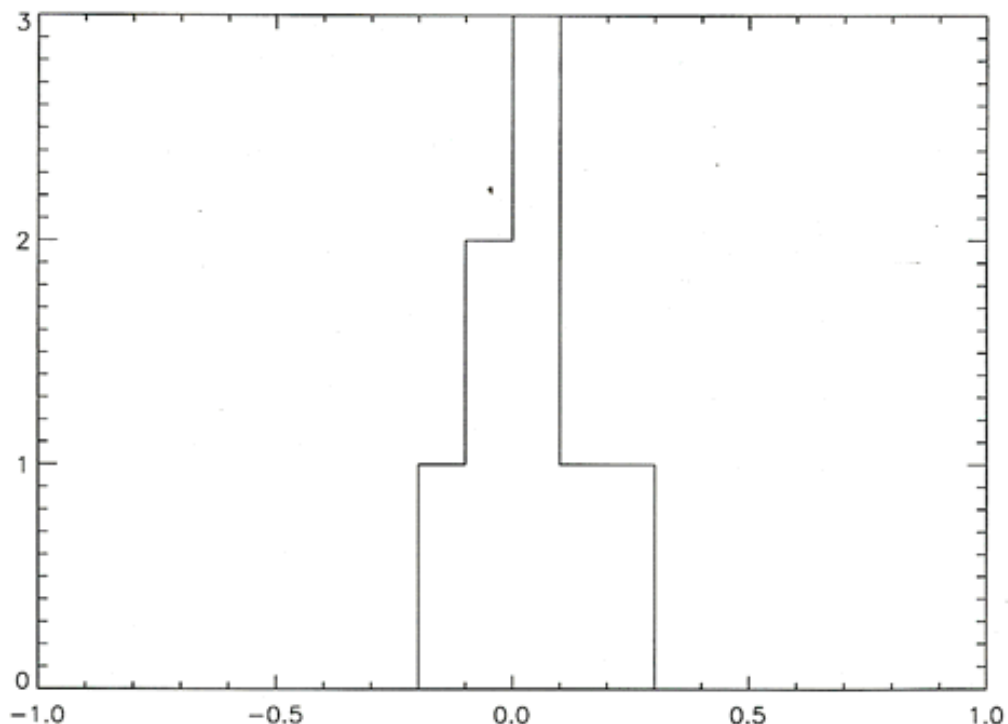




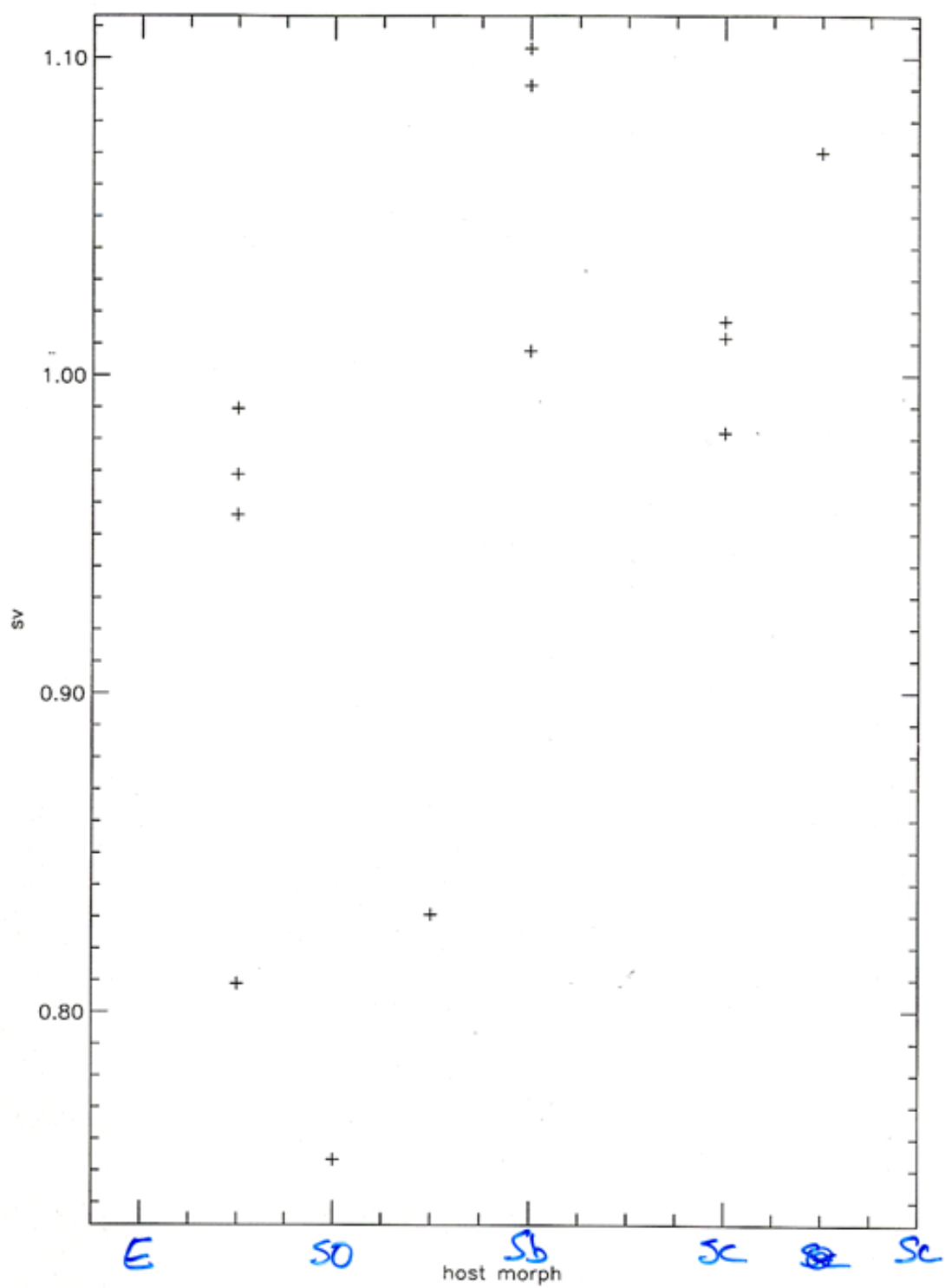
Result

- Split Hamuy et al. sample
magnitude dispersion from the
Hubble diagram

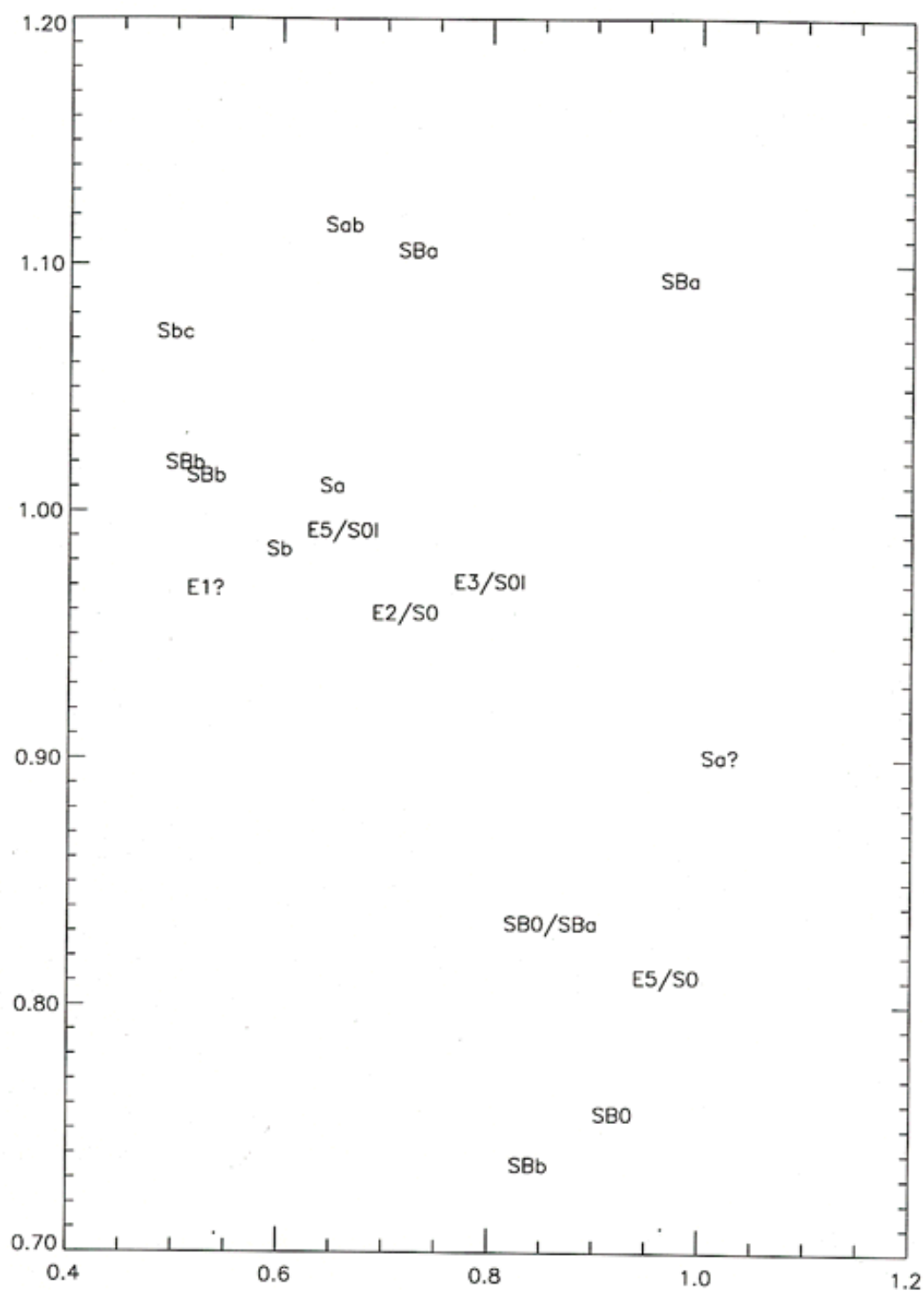
$$\sigma = 0.14 \text{ mag}$$



$\mu - \mu_{fit}$

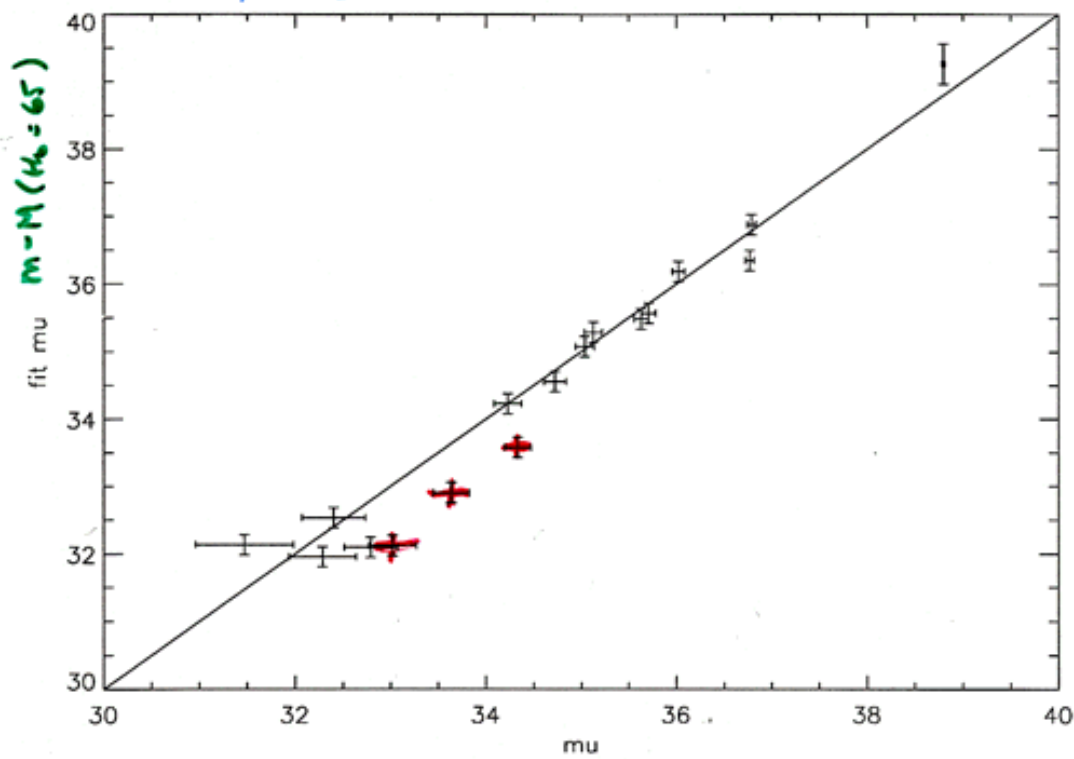


Su



B-V HOST

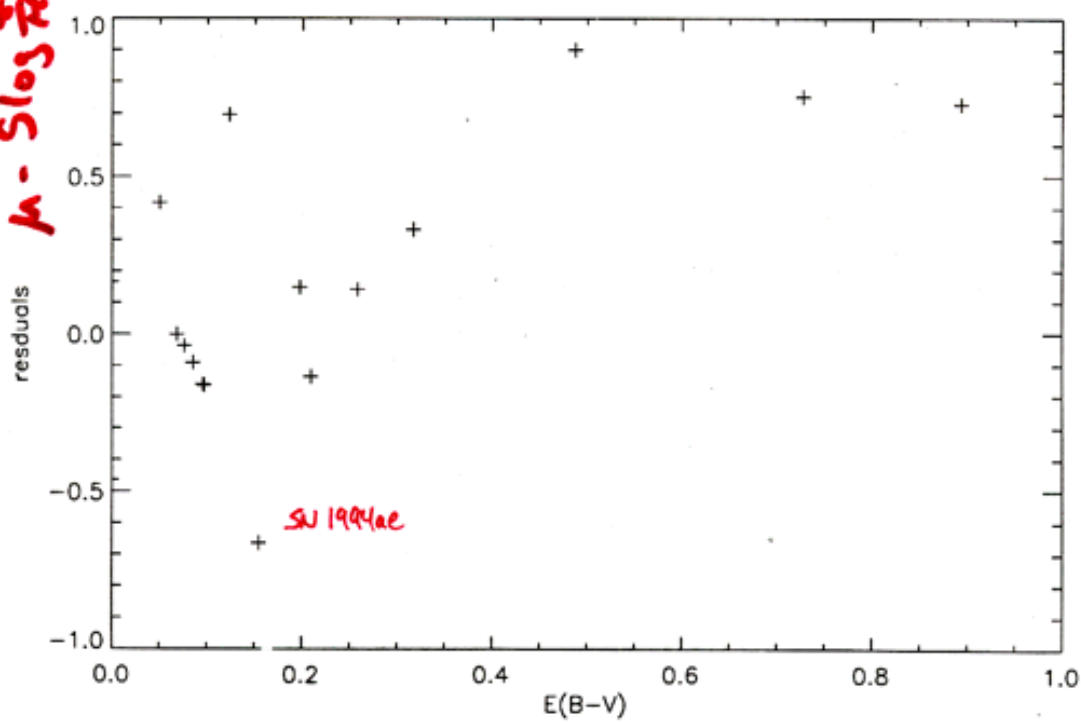
CfA SNe Ia (Riess et al.)

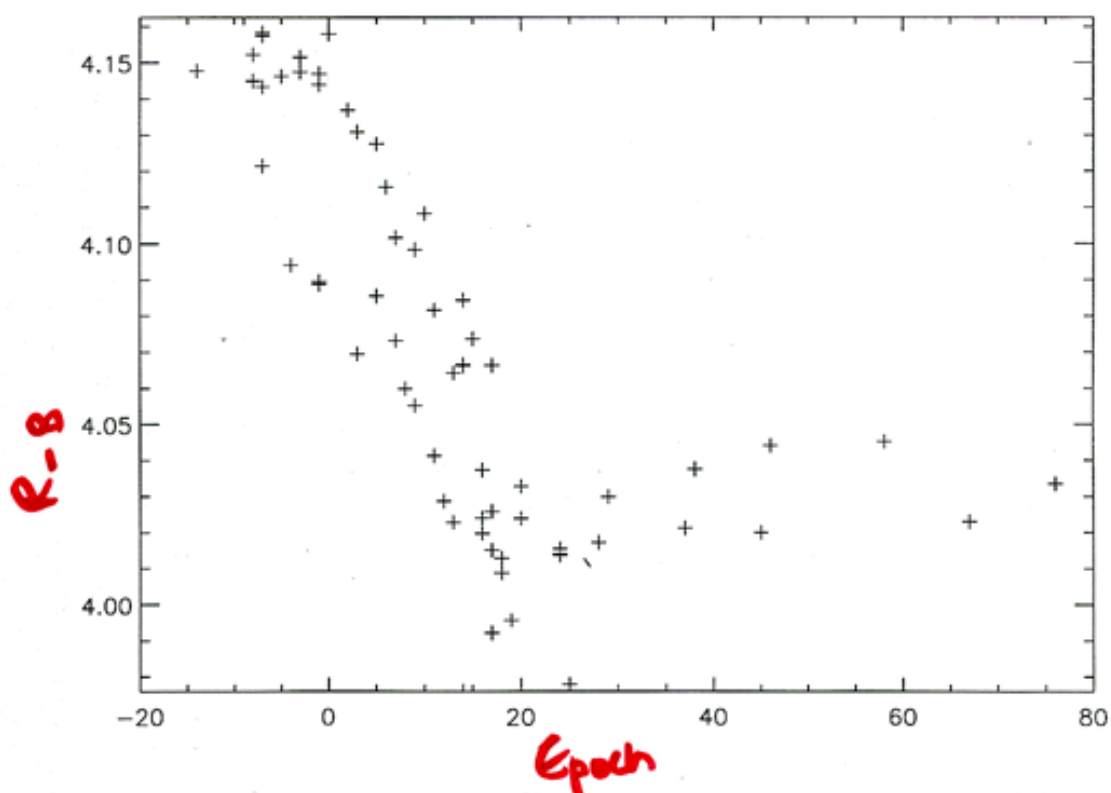
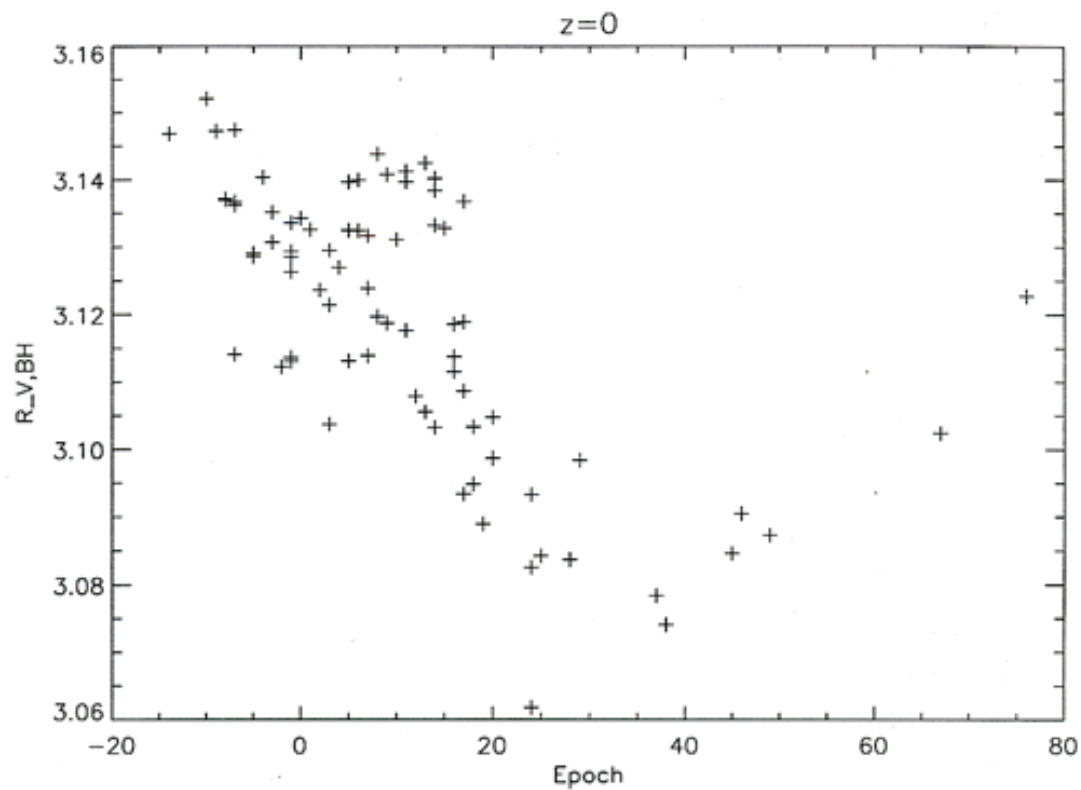


$$5 \log \frac{cz}{H_0} + 25 \quad H_0 = 65 \frac{\text{km}}{\text{s Mpc}}$$

123456789 2011M

$\mu - S \log \pi$





Conclusions

- * Not optimized for low- z Type Ia's
 - B and V only
 - Early epochs
- * Customize training set for the data
- * Extinction (hmmm...)
- * About as good as you can do with a single parameter
 - No bins in residuals
- * Easy to use.
 - I give you the curves, you stretch them
- * $\sigma = 0.14 \text{ mag}$

Extinction

- Does not work well for $E(B-V) > 0.4$
 - $B-V$ data only
- R_B, R_V depend on epoch & dust
 - High z !
- A problem for all template methods
- Biased against in mag-limited high- z searches
- Ridge line

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor The Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or The Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or The Regents of the University of California.